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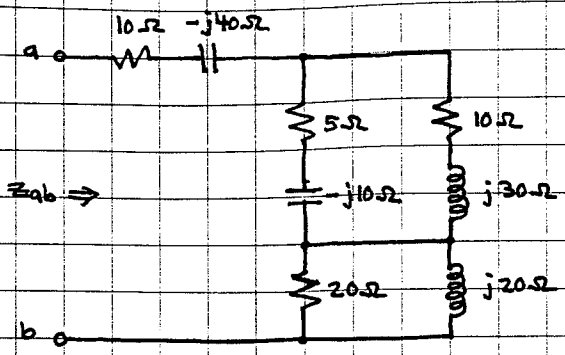
Ref: Nilsson & Riedel, Rev 6, Prob 9.23

IMPEDANCE CIRCUITS

OHM'S LAW
Example 2

ex:



Find impedance z_{ab}.

sol'n: Use same formulas for series and parallel z's as you would for R's.

$$z_{ab} = 10\Omega + -j40\Omega + (5\Omega - j10\Omega) \| (10\Omega + j30\Omega) + 20\Omega \| j20\Omega$$

Consider parallel z pieces:

$$20\Omega \| j20\Omega = 20\Omega \cdot 1 \| j = 20\Omega \cdot \frac{1 \cdot j}{1+j}$$

$$= 20\Omega \left(\frac{j}{1+j} \; \frac{1-j}{1-j} = \frac{1+j}{1^2+1^2} = \frac{1}{2} + j\frac{1}{2} \right)$$

$$= 10\Omega + j10\Omega$$

$$(5\Omega - j10\Omega) \| (10\Omega + j30\Omega) = 5\Omega \cdot (1-j2) \| (2+j6)$$

$$= 5\Omega \cdot \frac{(1-j2)(2+j6)}{1-j2+2+j6} = 5\Omega \cdot \frac{2+12+j(6-4)}{3+j4}$$

$$= 5\Omega \cdot \frac{14+j2}{3+j4} \; \frac{3-j4}{3-j4} = 5\Omega \cdot \frac{42+8+j(6-56)}{3^2+4^2}$$

$$= 5\Omega \cdot \frac{50-j50}{25} = 5\Omega \cdot (2-j2)$$

$$= 10\Omega - j10\Omega$$

$$z_{ab} = 10\Omega - j40\Omega + 10\Omega + j10\Omega + 10\Omega - j10\Omega$$

$$= 30\Omega - j40\Omega$$

polar form: $z_{ab} = \sqrt{30^2+40^2}\, e^{j\tan^{-1}\frac{-40}{30}} = 50\, e^{-j53^\circ}\ \Omega$